SCIENCE, AERONAUTICS, AND TECHNOLOGY

FISCAL YEAR 2000 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT — **MISSION COMMUNICATIONS SERVICES**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 1998 OPLAN 9/29/98	FY 1999 OPLAN 12/22/98	FY 2000 PRES BUDGET	Page Number
	(Thousands of Dollars)			
Ground Networks	221,600	211,200	228,800	SAT 5-4
Mission Control and Data Systems	148,100	143,100	150,500	SAT 5-11
Space Network Customer Services	31,100	25,700	27,000	SAT 5-21
Total	400,800	380,000	406,300	

Distribution of Program Amount by Installation

	FY 1998	FY 1999	FY 2000
Johnson Space Center	6,700	5,500	8,800
Marshall Space Flight Center	2,100	300	300
Dryden Space Flight Center	14,600	12,600	14,900
Glenn Research Center	9,800	10,100	10,100
Goddard Space Flight Center	205,600	187,400	192,000
Jet Propulsion Laboratory	159,400	161,000	174,900
Headquarters	2,600	3,100	5,300
Total	400,800	380,000	406,300

PROGRAM GOALS

The Space Communications goal is to provide high quality, reliable, and cost effective space operations services which enable Enterprise mission operations. Reliable electronic communications are essential to the success of every NASA flight mission, from planetary spacecraft to the Space Transportation System (STS) to aeronautical flight tests.

The Space Operations Management Office (SOMO), located at the Johnson Space Center, in Houston, Texas manages the telecommunication, data processing, mission operations, and mission planning services needed to ensure the goals of NASA's exploration, science, and research and development programs are met in an integrated and cost-effective manner. The SOMO is committed to seeking and encouraging commercialization of NASA operations services and to participating with NASA's strategic enterprises in collaborative interagency, international, and commercial initiatives. As NASA's agent for space operations services, the SOMO seeks opportunities for using technology in pursuit of more cost-effective solutions, highly optimized designs of mission systems, and advancement of NASA's and the nation's best technological and commercial interests. The content described in this section represents the Mission Communications Services portion of the SOMO responsibilities.

The Mission Communications Services segment of NASA's Space Communications program is composed of Ground Networks, Mission Control and Data Systems, and Space Network Customer Service. These programs establish, operate, and maintain NASA ground networks, mission control, and data processing systems and facilities to provide communications service to a wide variety of flight programs. These include deep space and Earth-orbital spacecraft missions, research aircraft missions, and sub-orbital flights. Mission support services such as orbit and attitude determination, spacecraft navigation and maneuver support, mission planning and analysis and other mission services are provided. New communications techniques, standards, and technologies for the delivery of communication services to flight operations teams and scientific users are developed and applied. Agency spectrum management and data standards coordination for NASA are conducted under this program.

STRATEGY FOR ACHIEVING GOALS

The Space Communications program provides command, tracking, and telemetry data services between the ground facilities and flight mission vehicles. This includes all the interconnecting telecommunications services to link tracking and data acquisition network facilities, mission control facilities, data capture and processing facilities, industry and university research and laboratory facilities, and the investigating scientists. The program provides scheduling, network management and engineering, pre-flight test and verification, flight system maneuver planning and analysis. The program provides integrated solutions to operational communications and information management needs common to all NASA strategic enterprises. The Mission Communications Services program, one part of NASA Space Communications program, provides systems and services to a large number of NASA missions, including planetary and interplanetary missions; human space flight missions; near-Earth and Earth-orbiting missions; sub-orbital and aeronautical test flights.

The range of telecommunications systems and services are provided to conduct mission operations, enable tracking, telemetry, and command of spacecraft and sub-orbital aeronautical and balloon research flights. Additionally, services and systems are provided to facilitate data capture, data processing, and data delivery for scientific analysis. The program also provides the high-speed computer networking, voice and video conferencing, fax, and other electronic mail services necessary to administer NASA programs. These communications functions are provided through the use of space and ground-based antennas and network systems, mission control facilities, computational facilities, command management systems, data capture and telemetry processing systems, and a host of leased interconnecting systems ranging from phone lines and satellite links to optical fibers.

The program provides the necessary research and development to adapt emerging technologies to NASA communications and operational requirements. New coding and modulation techniques, antenna and transponder development, and automation applications are explored and, based on merit, demonstrated for application to future communications needs. NASA’s flight programs are supported through the study and coordination of data standards and communication frequencies to be used in the future.

Many science and exploration goals are achieved through inter-agency or international cooperation. NASA’s Space Communications assets are provided through collaborative agreements with other U.S. Government agencies, commercial space enterprises, academia, and international cooperative programs. Consistent with the National Space Policy, NASA will procure commercially available goods and services to the fullest extent feasible, and will not conduct activities with commercial application that preclude or deter commercial space activities. Rather, NASA will develop selected technologies which leverage commercial investments and enable and foster the use of existing and emerging commercial telecommunications services to meet NASA’s space communications needs. These are all parts of the strategic approach to providing the vital communications systems and services common to all NASA programs and to achieve compatibility with future commercial satellite systems and services.

Efforts are continuing to consolidate and streamline major support contract services. In FY1996, a plan to transition to a consolidated space operations contract began and has been implemented in two distinct phases. In FY 1997, two short-term, fixed-price study contracts were awarded to develop an Integrated Operations Architecture (IOA) approach to consolidate space operations activities across the Agency. On October 1, 1998, a Consolidated Space Operations Contract (CSOC) was competitively awarded to the Lockheed-Martin Space Operations Company. This contract, managed by SOMO, is a 10-year, cost-plus-award-fee (CPAF) effort that became fully operational on January 1, 1999. This consolidated, integrated approach to space operations is expected to maximize space operations resources by reducing systems overlap and duplication. Significant efficiencies and economies are expected over the life of the CSOC contract. Additional efforts will be undertaken to consider other opportunities for accelerating the National Space Policy directive that NASA privatize or commercialize its space communication operations no later than 2005.

BASIS OF FY 2000 FUNDING REQUIREMENT

GROUND NETWORKS

	FY 1998	FY 1999	FY 2000
		(Thousands of Dollars)	
Deep Space Network – Systems	78,700	75,500	82,900
Deep Space Network – Operations	80,500	81,300	86,100
Spaceflight Tracking and Data Network - Systems	3,000	2,300	2,400
Spaceflight Tracking and Data Network - Operations	16,800	15,100	14,000
Aeronautics, Balloons, and Sounding Rockets - Systems	12,400	8,200	12,200
Aeronautics, Balloons, and Sounding Rockets - Operations	30,200	28,800	31,200
Total	221,600	211,200	228,800

PROGRAM GOALS

The Ground Networks program goal is to provide high quality, reliable, cost-effective ground-based tracking, command and data acquisition systems and services for NASA science and aeronautics programs. Launch, emergency communications, and landing support for the Space Shuttle is also provided by the Ground Networks facilities. The program provides for the implementation, maintenance, and operation of the tracking and communications facilities necessary to fulfill program goals for the NASA flight projects. The Ground Networks program also supports NASA programs in collaborative interagency, international, and commercial enterprises and independently provides support to other national, international, and commercial enterprises on a reimbursable basis.

STRATEGY FOR ACHIEVING GOALS

The Ground Networks program is comprised of the following elements: the Deep Space Network (DSN), managed by the Jet Propulsion Laboratory (JPL); the Spaceflight Tracking and Data Network (STDN), managed by the Goddard Space Flight Center (GSFC); the Aeronautics, Balloon and Sounding Rocket (AB&SR) tracking and data acquisition facilities managed by GSFC/Wallops Flight Facility (WFF); and the Western Aeronautical Test Range (WATR), managed by the Dryden Flight Research Center (DFRC). As the prime contractor for the CSOC, the Lockheed-Martin Space Operations Company will be responsible for providing space operational services beginning in January 1999.

Re-engineering efforts will continue on the STDN facilities, resulting in reduced operation and maintenance costs. NASA terminated S-band and C-band services at the Bermuda station in November 1998, following completion of two Space

Shuttle modifications. One permits earlier communications through the Tracking and Data Relay Satellite (TDRS) during the launch phase of the mission and the second allows onboard use of the GPS to replace the use of ground radar for Space Shuttle navigation. UHF Command services will continue on a reimbursable basis through March 1999. The UHF air-to-ground voice service remains available for Space Shuttle launch operations.

The number of missions serviced by the DSN facilities and the requirements of the individual missions will increase dramatically over the next several years. In anticipation of the increases, new antenna systems have been developed and obsolete systems are expected to be phased out or converted for alternate uses. The DSN has been reconfigured with four new 34-meter antenna systems located at Goldstone, California; Canberra, Australia; and Madrid, Spain. These 34-meter antennas will enable the expanded coverage requirements and provide simultaneous coverage of two deep space missions which are in critical phases. Currently, a 34-meter antenna transferred from the U.S. Army located at Goldstone is supporting the Solar Observatory for Heliospheric Observations spacecraft. An 11-meter antenna system has been installed at each DSN complex to provide science support for the Institute of Space and Astronautical Science (ISAS) Japanese VLBI Space Operation Program (VSOP) spacecraft.

The DSN has several on-going re-engineering efforts. These new processes allow the DSN to increase the tracking hours delivered while reducing costs. The processes include giving a single operator end-to-end control of the entire data acquisition process, redesigning systems that provide support data to allow automation and quicken response time, developing a process to better define DSN services which will allow customers to choose only the services necessary to support the mission, and providing systems support data which allow greater automation and quicker response time.

The DSN is the premier facility for tracking deep space probes and is occasionally supplemented by the facilities of other agencies or nations. NASA is actively working with industry to foster the enhancement of existing “commercial-off-the-shelf” (COTS) data processing systems to expand their applicability so that inexpensive and reliable communications services can be readily obtained for the new small-class missions. Future earth orbiting missions will be supported by commercially available tracking systems, enabled by such tools as the Very Large Scale Integration (VLSI) High-Rate Frame Synchronization and Data Extraction chips which have been transferred to industry.

New Ground Networks capabilities include two 11-meter antenna systems installed near Fairbanks, Alaska and at Svalbard, Norway to provide command and data acquisition support for the expanded number of Earth-observing missions which includes EOS AM-1 and Landsat-7. Also, the Low Earth Orbit Terminal (LEO-T) contract has been expanded to provide three autonomous 5-meter ground stations for space science mission support. The first of these systems will be installed in Puerto Rico and will be operationally ready to support the Far Ultraviolet Spectroscopy Explorer (FUSE) mission in FY 1999.

The Ground Networks program, in conjunction with other NASA elements, is demonstrating and implementing Global Positioning System (GPS) flight units on NASA-sponsored missions. This demonstration seeks to minimize future tracking and navigation activities. The Student Nitric Oxide Explorer (SNOE) mission demonstrates these new capabilities using commercial flight units as the primary source of this function. The Western Aeronautical Test Range is striving for even more efficiency as it provides NASA's capability for tracking, data acquisition, and mission control for a wide variety of flight research vehicles. The WATR provides both on-orbit and landing support to the Space Shuttle and communications with the Mir Space Station. Intense planning is underway to support the Reusable Launch Vehicle (X-33) and other wide range of vehicles with WATR resources.

NASA will pursue commercial ground tracking services for low-Earth orbit missions. Transition activities to the commercial operator will begin in FY 1999. Upon successful completion of transition activities, the 26-meter subnet will be operated at a reduced level until FY 2001 in order to meet prior project support commitments. The DSN will return to servicing only deep space missions, highly elliptical Earth orbiting missions, launch and early orbit phase, ground-based radio astronomy, and planetary radar astronomy activities.

SCHEDULE AND OUTPUTS

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Current	Plan
Deep Space Network					
Number of NASA missions	45	45	51	52	51
Number of hours of service	92,000	90,000	94,000	92,000	84,000
Ground Network					
Number of Space Shuttle launches	7	4	6	7	8
Number of NASA/Other ELV launches	25	40	25	26	25
Number of NASA Earth-Orbiting missions	33	33	32	30	37
Number of Sounding Rocket deployments	31	27	27	30	25
Number of Balloon deployments (scientific)	26	32	26	26	26
Number of hours of service (GN Orbital Tracking)	26,000	19,300	24,000	23,750	25,200
Western Aeronautical Test Range					
Number of NASA missions	1,100	750	1,200	1,100	1,200
Number of NASA research flights	750	660	900	750	350

DSN support of NASA missions and hours of service are dictated by actual launch dates and associated mission support requirements. In the WFF area, the change in the number of NASA earth-orbiting missions reflects a net increase in the number of missions to be supported based on documented requirements. New missions to be supported include: Earth Observing System (EOS) AM-1, Quickscat, and LANDSAT-7. The other increases shown are based on the current mission model reflecting planned support. Planning and development work on major priority missions such as the X-33, Hyper-X and Linear Aerospike SR-71 Experiment consumed much of the WATR resources. The changes in research flights was due to pre-flight and ground tests for UAV's and the Linear Aerospike SR-71 Experiment LASRE.

CONSOLIDATED SPACE OPERATIONS CONTRACT (CSOC)

Phase 1 Contract Award	May 1997
Phase 2 Proposal Due	January 1998
Phase 2 Contract Award	October 1998
Phase 2 Phase-In	October-December 1998
Phase 2 CSOC In Force	January 1999

The CSOC measures of performance apply to the Ground Networks, Mission Control Data Systems, and Space Network Customer Services.

ACCOMPLISHMENTS AND PLANS

The Space Shuttle launches were successfully supported through dedicated facilities of the Spaceflight Tracking and Data Network (STDN). The continuation of this support, further enabled by the implementation of the re-engineered STDN system elements, is expected throughout FY 1999 and FY 2000.

The STDN consists of the Merritt Island Launch Area (MILA) station and the Ponce de Leon inlet annex in support of Shuttle Launch and landing activities. The aging 9-meter hydraulic antennas at MILA will be replaced with electric drive systems, capable of functioning without an operator. Efforts in support of this initiative will begin in FY 1999. Technology developed in support of receiver, exciter, and ranging subsystems will be introduced in a phased manner to replace aging subsystems at MILA and Ponce de Leon.

Wallops Flight Facility (WFF) completed the installation of the 11-meter telemetry antenna systems at the Poker Flat Research Range near Fairbanks, Alaska and at Svalbard, Norway in preparation for support of the EOS AM-1, Quickscat, and Landsat-7 missions. Ground station and network integration and certification testing will be completed in the first half of FY 1999. The contract for the LEO-T systems was modified to include the delivery of three systems to be installed at Puerto Rico, Wallops Island, and Poker Flat. These systems will all be completed in FY 1999 and will provide a cost-effective command and data acquisition capability for low earth orbit missions. NASA is planning for the future of the McMurdo Ground Station (MGS) in Antarctica. The drivers for this station are the need to provide for predictable performance of MGS in support of Launch and Early Orbit Operations (LEOP), to provide for supplemental Earth Observing System (EOS) Polar Ground Network (EPGN) support, and to pursue a mutually beneficial relationship with the Air Force with regard to improved service and cost savings/sharing. Concept definition, project plans, and approval to proceed will be sought in FY 1999.

Low Earth orbit, expendable launch vehicle, sounding rocket, and atmospheric balloon mission support will be provided by a mix of permanent and transportable command, control, data acquisition, and tracking facilities. Successful support of two Pegasus launch operations was completed including the MINISAT from a mobile range deployment to the Canary Islands. The Redstone antennas recently installed at Poker Flat and at the White Sands Missile Range have successfully supported the NASA Sounding Rocket Program. Mobile support requirements for FY 1999 include missions in Norway and Puerto Rico. Planning continues for the mobile range support of the X-33 mission in California in FY 1999.

The WFF modernization upgrade of the FPQ-6 radar was completed in FY 1998. Work will be initiated on the replacement of a range safety tool in the Wallops Range Data Acquisition and Computational System. The acquisition of commercially available and maintainable PC-based telemetry front-end processors will be completed. These systems will be common to all Wallops ground stations and will replace obsolete, custom built systems currently in use. Work on the 11-meter antenna system upgrades required to support the Advanced Earth Orbiting Satellite (ADEOS) II mission will be initiated.

The DSN supported 61 NASA-sponsored missions, including Cassini which successfully completed the first of its two Venus flybys in April 1998. Mars Global Surveyor (MGS) continued in aerobraking activities. The Japanese Planet B Mars mission was launched in July 1998. The pace of spacecraft launches for exploration of the solar system will accelerate in FY 1999 as Mars, Discovery, and other programs launch multiple new missions. The Mars 98 mission will start with a dual launch, the Mars Climate Orbiter in December 1998 and the Mars Polar Lander in January 1999. Support of the Planet-B mission enroute to Mars will continue. The NEAR spacecraft will orbit an asteroid in January 1999. The Stardust Discovery mission will be launched in February 1999 on a cometary and solar wind mission. New Millennium's DS1 mission will be launched in October to examine an asteroid (and a comet if the mission is extended). At the same time, Galileo will continue its orbital tour of the Jovian system, especially Europa, Cassini will have gravity-assist maneuvers by Earth and Venus; and support for extended missions will continue. The DSN will provide support to these missions in addition to many other Earth orbiters and launch and early orbit phase supports for both cooperative and reimbursable missions.

The 11-meter antennas are performing below expectations. DSN management has formed a tiger team to address hardware and software-deficiencies and has committed the resources needed to operate the antennas in a manual mode to achieve the required science return. The capability to receive data from two spacecraft at a single beam has been implemented. This is required because of the number of missions that will be orbiting on the surface of Mars. This implementation will allow the DSN to better use the limited number of antennas that are available. As planned, the aging DSN 34-meter standard antennas at Australia and Spain will be retired and their role assumed by the newly constructed 34-meter Beam Waveguide antennas. Decommissioning is planned for the first quarter of FY 2000. The age of the antennas and cost of year 2000 software upgrades makes continuation of operations impractical beyond that date.

The DSN began implementing architectural changes in 1998. The changes involve the upgrade and automation of the 26-meter antennas, separating their electronics from those of the 34-meter and 70-meter antennas. Additional changes included the replacement of significant parts of electronics in the 34-meter and 70-meter antennas and replacing the data processing equipment at each complex with simpler commercial components. This, combined with on-going network control modifications scheduled for completion in 1999, will lead to dramatically reduced costs of network sustaining, maintenance and operations. Automated equipment will enable a single “connection operator” at a Complex to control the acquisition of data from a spacecraft and deliver it to a project.

Western Aeronautics Test Range (WATR) at Dryden Flight Research Center (DFRC) provides communications, tracking, data acquisition, and mission control for a wide variety of aeronautics and aerospace vehicles. The WATR primarily supports the Aero-Space Technology Enterprise and also provides support to the Human Exploration and Development of Space and the Mission to Planet Earth Enterprises. Special emphasis is placed on the Revolutionary Technology Leaps and Access to Space, Provide Safe and Affordable Human Access to Space, and Expand Scientific Knowledge of the Earth System programs. WATR customers include other NASA Centers, the U.S. Army, U.S. Air Force, U.S. Navy, Federal Aviation Administration and the aerospace industry.

The WATR is part of an integrated system of facilities that includes flight simulation, aircraft in the loop ground tests, flight data calibration and analysis, post-flight data analysis and archival, and remotely piloted vehicle systems. These facilities allow the DFRC to conduct flight research on a wide variety of aircraft. The WATR is a critical safety of flight element. Periodic upgrades of WATR assets ensures that consistency and quality of support are continued and that basic capabilities are available when new, short-term requirements are presented. As new programs and projects are conducted at the DFRC, existing capabilities are configured, expanded, and upgraded as necessary.

The wide range of WATR-supported vehicles covers the entire spectrum from spacecraft through high-performance and commercial test aircraft and science platform aircraft to long-duration high-altitude, Uninhabited Aerial Vehicles (UAVs). Major aeronautics programs supported by the WATR include the F-15 Advanced Control Technology Integration Vehicle (ACTIVE), the F-18 Systems Research Aircraft (SRA), F-15-B Aerodynamic Testbed, and the Pathfinder, Altus, and Centurian UAVs. Post-flight processing of Tu-144 flight data gathered in Russia is provided in support of the agency's High Speed Research program. The WATR also supports testing of the Crew Return Vehicle (X-38), a part of the International Space Station program, and the Reusable Launch Vehicle (X-33), part of the Access to Space program. The WATR works closely with other test ranges to provide support to not only the X-33 and X-34 but also the Hyper-X (X-43A) program which will be testing new propulsion and airframe systems. More programs are in the planning stages for support in FY 2000 and beyond.

To provide the most cost effective customer service, the WATR works closely with the AFFTC to find joint solutions to range challenges. Sharing range assets to support both NASA and other Air Force programs allows an overall reduction in the amount of range instrumentation on the Edwards Air Force Base installation. The sharing of resources has reduced costs at the WATR and increased the availability of range resources for customers. This will continue to benefit both the WATR and the Air Force by providing a common range infrastructure and shared range systems to support both agencies' programs.

The Extended Test Range Alliance (EXTRA) continues to solve the difficult challenge of developing a network of both traditional and nontraditional range systems to support a number of projects such as the X-33. Examples of this include collaborative agreements where one party provides the hardware and another party provides the operators and maintenance personnel. The team consists of members of the WATR as well as members from other NASA centers and DoD facilities.

Upgrades underway in the Video Control Center (VCC) will allow for the distribution and recording of multiple video feeds from the X-33 launch pad. A more powerful camera lens will make it possible to track the X-33 during launch and also high altitude UAVs. Additional improvements have been made in the long range communication capability which has improved the air-to-ground link between research aircraft and the ground station. These same systems are also used to support the Space Shuttle.

The capability to process and display Global Positioning System (GPS) parameters was incorporated into the Mission Control Center (MCC) and used to support the F-18 Sequented Ranging Assembly (SRA). Other projects such as the UAVs have also used this new capability. The Global Real-time Interactive Map (GRIM) was upgraded to handle the added requirements of such projects as X-38, LASRE, X-36, and ERAST. The Test Evaluation Command Control System (TECCS) was installed in the MCC to provide a back-up to the GRIM. Current and future projects require even more performance from the MCC display work stations. These systems and others will continually be upgraded to meet new requirements.

The Telemetry and Radar Acquisition Processing System(s) (TRAPS) were upgraded to support four real-time Pulse Code Modulation (PCM) telemetry streams. In addition, the capability to process up to 32 streams of wide band Frequency Modulated (FM) and constant bandwidth data was incorporated into the TRAPS system. This was used successfully by the F-16 Supersonic Laminar Flow Control project and will be used by other projects in the future. Also, the capability to run the F-15 ACTIVE engine model software in real-time was demonstrated with success. Planned upgrades to the telemetry front end system are required to support such projects as X-33 and ERAST but will ultimately benefit all projects.

The relocation of the mobile systems from the Ames Research Center (ARC) to DFRC was accomplished as planned. Mobile systems will continue to be upgraded to provide a quick response rapid deployment capability within the WATR. The increase in unpiloted vehicles has placed a high demand on this type of capability. A new system is being built to replace one of the old Mobile Operations Facilities (MOFs) and will be used to support the X-33 project. The Laser Tracker will be maintained long enough to support current commitments such as the T-38 Jet Inlet Redesign and will then be removed from service.

The relocation of aircraft from the ARC to the DFRC has provided more opportunities to send real-time data to remote locations. The presentation of research data in real-time to researchers remote from DFRC is a key element to the future success of the WATR and the research missions it supports. The "Virtual Flight Research Center" and "Virtual Control Room" concepts will evolve based on work already done within the mission control community and the application of new network technology.

BASIS OF FY 2000 FUNDING REQUIREMENTS

MISSION CONTROL AND DATA SYSTEMS

	FY 1998	FY 1999	FY 2000
		(Thousands of Dollars)	
Mission Control - Systems	13,400	16,700	10,800
Mission Control - Operations	47,300	42,400	43,600
Data Processing - Systems	3,000	2,800	4,900
Data Processing - Operations	84,400	81,200	91,200
Total	148,100	143,100	150,500

PROGRAM GOALS

The Mission Control and Data Systems program goal is to provide high-quality, reliable, cost-effective mission control and data processing systems and services for spaceflight missions; data processing, and flight dynamics services for NASA flight projects. The program provides for data systems, telecommunications systems technology demonstrations, and coordination of data standards and communications frequency allocations for NASA flight systems. The Mission Control and Data Systems program provides for the launch and early orbit implementation, maintenance, and operation of the mission control and data processing facilities necessary to ensure the health and safety and the sustained level of high quality performance of NASA flight systems. The program provides and demonstrates key technologies and innovative approaches to satisfy Strategic Enterprises' mission needs and to maximize NASA's ability to acquire commercial services that meet its communications and operations needs. Through these efforts, the program also seeks to promote sustained U.S. economic and technological leadership in commercial communications.

STRATEGY FOR ACHIEVING GOALS

The Mission Control and Data Systems program, primarily managed by the GSFC, is comprised of a diverse set of facilities, systems and services necessary to support NASA flight projects. The Lockheed Martin Space Operations Company was awarded the Consolidated space Operations Contract (CSOC) and will be the primary contract responsible for systems engineering, software development and maintenance, operations, and analytical services beginning in January 1999.

The mission control function consists of planning scientific observations and preparing command sequences for transmission to spacecraft to control all spacecraft activities. Mission Operations Centers (MOC's) interface with flight dynamics and communications network, and science operations facilities in preparation of command sequences, perform the real-time uplink of command sequences to the spacecraft systems, and monitor the spacecraft and instrument telemetry for health, safety, and system performance. Real-time management of information from spacecraft systems is crucial for rapid determination of the condition of the spacecraft and scientific instruments and to prepare commands in response to emergencies and other unplanned events, such as targets of opportunity.

Mission control facilities operated and sustained under this program are Mission Operation Centers (MOCs) for the Hubble Space Telescope (HST) program; the International Solar Terrestrial Physics (ISTP) Wind, Polar, and Solar Observatory for Heliospheric Observation (SOHO); Rossi X-ray Timing Explorer (RXTE), TOMS-Earth Probe (EP) , Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX); Fast Auroral Snapshot (FAST); Transport Region and Coronal Explorer (TRACE); and Submillimeter Wave Astronomy Satellite (SWAS) missions, and the Multi-satellite Operations Control Center (MSOCC) which supports the Compton Gamma Ray Observatory (CGRO), Upper Atmosphere Research Satellite (UARS), Extreme Ultraviolet Explorer (EUVE), and Earth Radiation Budget Satellite (ERBS) missions. The Advanced Composition Explorer (ACE) and Tropical Rainfall Measurement Mission (TRMM) are also operated out of GSFC MOC's. Data processing support is provided for the ISTP/Geomagnetic Tail (Geotail) and Extreme Ultraviolet Explorer (EUVE) missions.

The CGRO has phased into the TPOCC architecture of distributed workstations first used for the International Monitoring Platform (IMP-8) mission. NASA's SAMPEX, FAST, and Submillimeter Wave Astronomy Satellite (SWAS) missions will be operated from a common control facility for Small Explorer missions. The SWAS Mission Operations Center has been completed. The Wide Field Infrared Explorer (WIRE) control center has also been completed. These workstation systems will allow for increased mission control capability at reduced cost.

The first launch of a Medium-class Explorer (MIDEX) is currently scheduled for January 2000. Approximately one spacecraft per year will be launched, with potentially every other MIDEX mission operated from GSFC, dependent on successful Principal Investigator teaming arrangements. To minimize operations costs, plans for the MIDEX missions include consolidating the spacecraft operations, flight dynamics and science data processing all into a single multi-mission control center. Many of the functions will be automated using a commercial expert system product. The control center system will be used for spacecraft integration and test, thereby eliminating the need and cost of unique spacecraft manufacturers integration and test systems.

Other mission control systems include the Space Shuttle Payload Operations Control Center (POCC) Interface Facility and the Command Management System. The Space Shuttle POCC Interface Facility (SPIF) is being upgraded with a low-cost, PC-based front-end data system now operating in shadow mode. The SPIF provides a single interface to the Mission Control Center for use of spacecraft mission control facilities to access spacecraft deployed by the Space Shuttle. The Command Management System generates command sequences to be used by mission control centers. A User Planning System, currently being upgraded to a workstation-based environment compatible with the Network Control Center (NCC) configuration, is provided for scheduling communications with spacecraft supported by the Tracking and Data Relay Satellite System (TDRSS); and the Flight-to-Ground Interface Engineering Center provides flight software pre-flight and in-flight simulation and development support for GSFC flight systems. An Operations Support Center maintains status records of in-flight NASA systems.

The data processing function captures spacecraft data received on the ground, verifies the quantity and quality of the data and prepares data sets ready for scientific analysis. The data processing facilities perform the first order of processing of spacecraft data prior to its distribution to science operations centers and to individual instrument managers and research teams.

Data processing facilities include the Packet Data Processing (PACOR) facility, the Data Distribution Facility, and the Telemetry Processing Facility. The PACOR facility utilizes the international Consultative Committee for Space Data Systems data protocol to facilitate a standardized method of supporting multiple spacecraft. PACOR provides a cost-effective means of processing flight data from SAMPEX, EUVE, CGRO, SOHO, SWAS, RXTE, TRMM, and HST spacecraft missions. The transfer of EUVE to the University of California at Berkley in FY 1998 and the relocation of CGRO processing to the workstation-based PACOR II in FY 1998 resulted in the closure of the older PACOR I system.

The Data Distribution Facility (DDF) performs electronic and physical media distribution of NASA space flight data to the science community. The DDF has been a pioneer in the use of Compact Disk-Read Only Memory technology for the distribution of spacecraft data to a large number of NASA customers. Specialized data processing services are provided by the Telemetry Processing Facility for the ISTP missions (Wind, Polar, and Geotail). The Spacelab Data Processing Facility, located at the MSFC, processes data from Space Shuttle payloads. Specialized telemetry processing systems for NASA's Space Network are also provided under this program.

The Mission Control and Data Systems program provides for the operation, sustainment, and improvement of NASA's Flight Dynamics Facility (FDF). Funding for the FDF is used to: provide orbit and attitude determination for operating NASA space flight systems, including the Tracking and Data Relay Satellite (TDRS) and the Space Shuttle; develop high-level operations concepts for future space flight systems; modify existing FDF systems to accommodate future missions; develop mission-unique attitude software and simulator systems for specific flight systems; generate star catalogues for general use; and conduct special studies of future orbit and attitude flight and ground system applications. It is critical to continuously know the location of spacecraft so as to communicate with the system and to know the orientation of the spacecraft to assess spacecraft health and safety and to perform accurate scientific observations. The type and level of support required by spacecraft systems is dependent on the design of its on-board attitude and control systems, including its maneuver capabilities, and the level of position and pointing accuracy required of the spacecraft. Automated orbit determination systems for TDRS and other spacecraft systems are also under development.

Besides the operation of currently deployed spacecraft and the modification and development of mission control and data processing systems to accommodate new flight systems, the program also supports the study of future flight missions and ground system approaches. Mission control and first-order data processing systems are less costly systems. Yet, proper economy of mission planning requires solutions that integrate ground and flight system development considerations. Special emphasis is given by the Mission Control and Data Systems program to seeking integrated solutions to spacecraft and ground systems designs that emphasize spacecraft autonomy; higher data transmission and processing rates; ease and low cost of operation; reuse of software; and selected use of advanced hardware and software design techniques to increase the return of space flight system investments at equal or lower cost than is required to support today’s mission systems.

The Mission Control and Data Systems program supports advanced technology development at GSFC, JPL and GRC. The GSFC team, including contractors and universities, provides advanced technology in several area such as tracking and data acquisition future systems, communications and telemetry transport, and advanced space systems for users. Anticipating a future mission set characterized by large numbers of rapid, low-cost missions, the JPL team invests in technologies which can increase the overall capacity-to-cost ratio for the Deep Space Network. Efforts are focused on core technologies unique to, and critical for, deep space telecommunications, tracking and navigation, and radio science. Current technology areas include antenna systems, low noise systems, frequency and timing, radio metric tracking, navigation, network automation, atmospheric propagation and optical communications. The Glenn Research Center team identifies, develops, and demonstrates advanced radio frequency antennas, amplifiers, receivers, digital communications and hybrid network technologies and services for use in NASA missions and commercial systems.

The Mission Communication Services advanced technology development has three forms that include near term (1-3 years) demonstration and application of data management and telecommunications technology and procedures, mid-range (3-5 years) development of ground and space flight communications systems; and a long-term, pre-competitive technology development and demonstration make up. Consideration of innovative applications of commercial “off-the-shelf” (COTS) technology is emphasized. Such applications often open new market opportunities to suppliers of these technologies resulting from their NASA experience. Additionally, in response to White House National Space Policy, NASA is planning to transition its communications operations to commercial services. Technology developments and demonstrations focus on technology and service gaps to enable utilization of commercially provided services.

A critical element of the Mission Control and Data Systems program is the securing of adequate frequency spectrum resources which are required in the performance of all flight missions, piloted and unpiloted, including spectrum for all active emitters as well as passive sensors. GRC, in concert with NASA Headquarters Office of Space Flight, manages these resources for the Agency and coordinates frequency spectrum requirements with other federal agencies, industry and regulatory bodies to obtain all requisite authorizations to operate telecommunications systems associated with NASA programs. Consistent with its charter pursuant to both the Space Act of 1958 and the Communications Satellite Act of 1962, NASA also serves as an advocate for obtaining the unique frequency spectrum allocations required by the commercial sector to exploit satellite technology for future generation telecommunications systems. In compliance with the 1992 Telecommunications Authorization Act, NASA actively participates in the Interdepartment Radio Advisory Committee to establish National and International spectrum management policies.

SCHEDULE AND OUTPUTS

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Current	Plan
Number of NASA spacecraft supported by GSFC mission control facilities	19	17	16	22	23
Number of mission control hours of service (thousands)	56,000	56,000	40,000	66,000	67,000
Number of billions of bits of data processed	31,400	56,000	60,900	64,500	67,000
Number of NASA/Other missions provided flight dynamics services	41	37	30	44	49
Number of NASA/Other ELV launches supported by flight dynamics services	34	34	34	34	22

The FY 1998 actual mission control and data processing support reflects the TRMM and TRACE launches. Planned support for fiscal years 1999 and 2000 reflect Landsat-7 and EOS AM-1 launches. The number of missions provided flight dynamics services reflects the current mission model and includes pre-Phase A support for missions such as Earth Orbiter (EO)-1, Venus 2000, and Next Generation Space Telescope.

ACCOMPLISHMENTS AND PLANS

The Mission Control and Data Processing program has pursued proactive measures to consolidate functions, close marginal facilities, and reduce overall contractor workforce to reflect the Agency's goals. Examples include the transition of the EUVE MOC operations to TPOCC workstation systems and the outsourcing of these operations to the University of California at Berkeley (UCB), the completion of SAMPEX science transition to PACOR II, the in-process CGRO transition to TPOCC and PACOR II systems, and the use of automation to monitor routine spacecraft health and safety functions to enable smaller flight operations teams and reduced operations schedules.

Mission control was performed for the HST, CGRO, UARS, EUVE, SAMPEX, FAST, TRACE, SWAS, ICE, IMP-8, ERBS, TOMS-EP, RXTE, ISTP WIND, POLAR, SOHO, and ACE.

Packet data processing operations were provided for the HST, CGRO, EUVE, SAMPEX, FAST, SOHO, TOMS-EP, and RXTE, while TRACE received limited support. The Time Division Multiplexed services were provided for the Geomagnetic Tail, UARS, ERBS, ICE, IMP-8, POLAR, and WIND. Data processing for the Spacelab missions was performed at MSFC. Efforts were continued during FY 1998 on the ISTP Wind, Polar, SOHO and Geotail reengineering initiative to consolidate systems and operations around a greater use of commercial products to substantially reduce recurring costs aimed at extending mission life beyond FY 1998.

Flight dynamics services were provided to all NASA space flight missions that utilize NASA's Space Network and to selected elements of the Ground Network, including the Space Shuttle, Expendable Launch Vehicles, and satellite systems. A new operations concept for flight dynamics was developed. The new concept defines an approach to reduce flight dynamics costs by implementing new technology. Attitude software and simulator development was provided for the TRACE, ACE, and TRMM flight systems.

Among systems implementation projects, development of TPOCC systems for the TRMM and ACE spacecraft was completed, including the procurement of workstations, processors, and software. Modifications of the Command Management System effecting workstation deployment to specific MOC's were completed, with CGRO the only residual mission operating on a reduced configuration IBM mainframe. TPOCC development for the EUVE missions was completed and the transition for CGRO continued. The development of innovative spacecraft integration and test and mission operation single system ground support development efforts for the MIDEX Microwave Anisotropy Probe (MAP) and MIDEX Imager for Magnetopause to Aurora Global Exploration (IMAGE), and the Small-class Explorer (SMEX) WIRE MOC's will be continued. The Integrated Test and Operations System (ITOS) was implemented for the SMEX TRACE mission and was utilized for launch and early orbit support and now for routine operations.

The spacecraft managed by GSFC's mission control facilities are supported by various NASA communications networks, including the TDRSS, the DSN, the WFF, and transportable ground systems. A wide range of communications and systems interfaces must be managed to accomplish the function of mission control. NASA mission operations personnel support the planning and development of future mission systems and continuous changes to operational spacecraft software systems, as well as the operation of current ground control systems.

Transfer of data systems technologies to flight project use occurred in the areas of software reuse, Very Large Scale Integration (VLSI) applications, expert system monitoring of spacecraft control functions, and packet data processing systems. Software reuse, expert systems, VLSI user interface, workstation environments, and object-oriented language applications continued. The Mission Control and Data Systems programs will continue to integrate modern technology into mission operations support systems through the use of systems like the Generic Spacecraft Analyst Assistant (GenSAA) for automation, software-based telemetry front-end processing systems and the Mission Operations Planning and Scheduling System, case-based and model-based reasoning tools, and commercial orbit planning systems.

In support of Advanced Technology Development, planning and implementation continued on demonstrating optical laser communications between the ground and an Earth-orbiting spacecraft using the JPL ground facilities and the Japanese ETS-VI satellite. A contract was placed for a 4th-generation, lightweight, low-power-consuming radio transponder for users of the TDRSS.

Conversion of CGRO to TPOCC and PACOR II systems was completed in FY 1998. The ISTP reengineering systems for mission control and science processing will begin phase-over to operations in FY 1999. MOC development for WIRE has been completed. MOC development for Landsat-7 will be completed, incorporating a commercial state modeling tool to help automate operations. RXTE and CGRO operations have incorporated GenSAA and other automation tools to promote reduced shift staffing. Attitude software and simulator development is being provided for the TRACE, WIRE, and TRMM flight systems. The TRMM and TRACE missions will be supported by GSFC's data processing program. The SAMPEX flight dynamics operations support will finalize its transition from the Flight Dynamics Facility at GSFC to the University of Maryland's Flight Dynamics Control Lab in FY 1999. Flight dynamics ground systems will be provided for EOS AM-1, EOS PM-1, and LANDSAT-7.

Reimbursable support will be provided to multiple missions, including Geostationary Operational Environmental Satellite (GOES) and National Oceanic Atmospheric Administration (NOAA) programs. Mission planning for future missions such as HST Servicing Missions, Next Generation Space Telescope, EO-2 and EOS will be performed.

Advanced technology initiatives will continue. The 4th generation TDRSS radio transponder engineering unit is underway. Work on deep space radio transponders and data coding technology continues.

Mission Control and Data Systems provided Mission Control, Flight Dynamics and Data Processing service for the TRMM and TRACE missions launched in FY 1998; similar support will be provided to the Landsat-7 mission scheduled to be launched in FY 1999. Significant development, test, and pre-launch support associated with the MIDEX and SMEX missions are part of the Mission Control and Data Systems activity.

Emphasis upon commercial products, artificial intelligence applications and advanced graphical displays will be continued in FY 1999 for application in MIDEX and future SMEX missions. Evolution of systems to a single integrated mission control, command management, flight dynamics, and first-level science processing system will continue. A new Flight Dynamics Facility (FDF) operations concept to perform routine operations as integral functions within mission control centers will be fully implemented in FY 1999. New flight dynamics technology development for autonomous space and/or ground spacecraft navigation and control will be major efforts.

Preparations for the HST Third Servicing Mission will continue, including the delivery of the Vision 2000 ground system, delivery of the new flight control computer flight software, and the payload computer ACS support system. Development efforts will take place in preparation for TRACE, SWAS, WIRE, and MIDEX missions.

The Mission Operations and Data Systems program will focus efforts at operations automation. Mission Control and Data Systems will complete development efforts on the RXTE Automated POCC (APOCC) and the CGRO Reduced Operations by Optimizing Tasks and Technologies (ROBOTT) efforts. Automation was provided for TRACE to promote single shift staffing for operations. Mission Control and Data Systems will actively lead and participate in establishing new architecture directions and rapid prototyping, exploring system autonomy concepts, and use of commercial-off-the-shelf products.

Mission Control and Data Systems program will continue the lead in scoping and prototyping Mission Operations Control Architecture (MOCA) elements such as the use of Transmission Control Protocol/Internet Protocol or Space Communications Protocol Standards for ground and flight communications, the use of knowledge-based control languages, ground and space autonomy; and active participation in the American Institute of Aeronautics and Astronautics Spacecraft

Control Working Group to infuse emerging operations standards in the areas of satellite control. Exploration of the promise of advanced communications technologies will continue throughout this period.

WIRE, SWAS, IMAGE, and HST SM3 development will be completed in FY 1999. Developments will continue for the MIDEX and SMEX series as well as for the fourth HST Servicing Mission (HST SM4). Development efforts on WIRE, MAP, Imager for Magnetopause-to-Aurora Global Exploration (IMAGE), EO-1, and similar missions will realize benefits from modern technology, commercial products, and more cost-effective processes. A prime example would be a single system to perform spacecraft integration and test and mission operations. The flight dynamics work will continue to be provided in the areas of ground support system development, analysis, and automation tools. In the area of analysis, work will continue with advanced mission studies needed for pre-phase A efforts, while Phases C and D work will be done to support various EOS, MIDEX, and SMEX missions. The ground systems for those missions will also be developed. Automation efforts will continue in an effort to reduce costs and increase the capability of spacecraft. This will include such items as onboard maneuver planning and station keeping that permits such mission scenarios as formation flying. Additional work will be completed in the area of mission planning tool development that will be in partnership with industry. Throughout all of these efforts, continual process improvement in the areas of analysis and software development will continue to occur with a view toward reducing costs and cycle time and improving quality.

The Advanced Communications Technology Satellite (ACTS) has completed its period of normal station kept operation and commenced a period of extended life operation in an inclined, fuel saving orbit in FY 1998. Reversion to this mode of operation extends its life by 2 additional years. Continued use of the satellite through FY2000 requires the use of tracking earth terminals. The system continues to contribute to NASA's transition to commercial services by its use as a testbed for resolving technical issues.

A GRC experiment to demonstrate the feasibility of using commercially provided Direct Data Distribution (D3) services from low earth orbiting NASA and commercial spacecraft was initiated in FY 1998 and is now in the concept development phase. A detailed experiment plan was developed to demonstrate the D3 concept using a K-Band phased array antenna (under cooperative development with Raytheon), multi-channel broadband modems (leveraging a 155-Mbps modem chip set developed with SICOM), and compact commercial ground-based tracking terminals. Plans to manifest the space segment of the experiment on the Space Transportation System using the GSFC Hitchhiker carrier system are in process. The ground segment will be located to communicate with the STS and interface with terrestrial telecommunications networks. Plans are being developed for insertion of the commercial D3 capability into International Space Station communications upgrades, near-Earth science spacecraft, and next-generation LEO satellite systems.

During FY 1998 and FY 1999 GRC evaluated industry responses to a CBD announcement requesting information on the suitability of planned commercial systems to meet NASA communications needs in near-Earth orbits. Preliminary results emphasized the need for focused technology development in order for NASA missions such as ISS to use the commercial systems with some modifications. Planning will be initiated in FY 1999 to collaborate with suitable commercial partners on technologies to enable a commercial Space Internet Architecture and NASA' us use of the commercial communications and operation services it will provide. The commercial Space Internet will enable spacecraft instruments to be accessed by principle investigators directly as a node on the Internet. A first generation commercial network transponder and associated inter-orbital intersatellite link components will enable near-Earth spacecraft to communicate directly with selected commercial non-GEO and GEO satellites. Development of a space communications and networks testbed on ISS will allow rapid demonstration of emerging technologies and augmentation of ISS data transmission capabilities. In FY 2000, GRC will extend its efforts to understand the signal propagation characteristics to millimeter wave frequencies (Ka-band and above) in support of long-term, pre-competitive technology development.

In FY 1999 GRC will initiate the development of Ka-band traveling wave tube (TWT) breadboard leading to TWT amplifiers (TWTA) for use in deep space missions that will return science data via the upgraded Deep Space Network. In FY 2001 the engineering model TWTA will be completed and the first of several flight model TWTAs will be initiated jointly with JPL.

In FY 1998 the vehicle for NASA/DoD/Industry collaboration on development of pre-competitive technologies and service enabling demonstrations of mutual benefit to all, transitioned from the NASA-led Satellite Alliance USA to the DoD-led Space Technology Alliance. The Office of Chief Technologist will facilitate future collaborative efforts by NASA.

During FY 1998, the NASA Spectrum Management Program participated in the US Delegation to the 1997 World Radio-communications Conference (WRC-97) and contributed to the significant success achieved in the area of space science related proposals. NASA also provided critical support to US efforts at WRC-97 aimed at defending the radio navigation satellite service spectrum used by the Global Positioning System (GPS). Study efforts were begun that focused on sharing issues in preparation for WRC-2000 and beyond. Proposals were developed regarding passive microwave sensor bands above 70 GHz. Significant activities were carried out, nationally and internationally, to support the use of GPS for space navigation and to secure the necessary regulatory protection of such use. Efforts were begun to identify spectrum needed to support broadband aeronautical telemetry requirements and coordination of these requirements within Government and industry. NASA continued to seek means to maximally utilize the limited and valuable orbit spectrum resources it needs to carry out its missions.

In FY 1999, the Spectrum Management Program will develop and advocate the Agency proposals for WRC-2000. Study efforts laying the groundwork for these proposals will be completed and recommendations formulated within the relevant International Telecommunications Union study groups and working parties. NASA will also continue efforts toward improving the regulatory status for frequency bands that are vital to carrying out the Agency's missions. NASA will continue to support US efforts at maintaining an interference free environment for the Global Positioning System and to garner support from the World's space agencies for space-based radio navigation. NASA will prepare for the WRC-2000 Conference Preparatory Meeting (CPM 99-2) scheduled for the fall of 1999.

In FY 2000, the Spectrum Management Program will participate in the conference Preparatory Meeting (CPM 99-2) to ensure that the technical bases needed to support US/NASA proposals at WRC-2000 is reflected in the CPM Report to the Conference. NASA will finalize proposals for WRC-2000 and participate in the US preparatory process. NASA will serve on the US Delegation to WRC-2000, providing leadership on space science issues and providing support to other issues of concern to NASA and the US such as GPS.

BASIS OF FY 2000 FUNDING REQUIREMENT

SPACE NETWORK CUSTOMER SERVICES

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Space Network Customer Services	31,100	25,700	27,000

PROGRAM GOALS

The goal of the Space Network Customer Service program is to provide high quality, reliable, cost-effective customer access to the multi-mission space telecommunications network serving all TDRS-compatible Earth orbiting and suborbital flight missions and to provide network control and scheduling services to customers of both the Space Network and selected Ground Networks elements.

STRATEGY FOR ACHIEVING GOALS

This program develops and maintains both the management and technical interfaces for customers for the Space Network. The Network Control Center (NCC), located at the Goddard Space Flight Center in Maryland, is the primary interface for all customer missions. The primary function of the NCC is to provide scheduling for customer mission services. In addition the NCC generates and transmits configuration control messages to the network's ground terminals and TDRS satellites and provides fault isolation services for the network. The Customer Services program also provides comprehensive mission planning, user communications systems analysis, mission analysis, network loading analysis, and other customer services and tests to insure network readiness and technical compatibility for in-flight communications.

The Lockheed Martin Space Operations Company was recently awarded the Consolidated Space Operations Contract (CSOC) and will be the primary contractor responsible for systems engineering, software development and maintenance, operations, and analytical services beginning in January 1999.

The Customer Services program also undertakes network adaptations to meet specific user needs and provides assistance to test and demonstrate emerging technologies and communications techniques. A low power, portable transmit/receive terminal, called Portcom, which operates with TDRS spacecraft has been demonstrated. Potential applications include data collection from remote sites where commercial capabilities do not exist, such as NOAA ocean research buoys and National Science Foundation (NSF) Antarctic activities. A series of tests are being conducted with Japanese and European satellites and data acquisition communications systems for mutual provision of emergency operational spacecraft support.

SCHEDULE AND OUTPUTS

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Current	Plan
Number of NASA spacecraft events supported by the NCC	80,900	76,000	98,000	99,900	100,800

The number of NASA Spacecraft events supported by the NCC increased in FY 1998 with the TRMM and ETX-VII missions and will increase further with the FY 1999 additions of Landsat-7, EOS AM-1, and the International Space Station (ISS) assembly activities. The FY 2000 increase is due to the anticipated full-up support of the ISS mission.

ACCOMPLISHMENTS AND PLANS

Implementation was continued on an improved, distributed architecture for the NCC which will be Year 2000 (Y2K) compliant. When completed, this modification will provide more efficient use of the network capabilities, improved ability to resolve scheduling conflicts among customer missions, and provide standard commercial protocols for both internal and customer interfaces. This architectural change will be undertaken over several years and accomplished segment by segment. The segment of the control center to be modified first is the service scheduling system.

The NCC modifications to the scheduling system continued including incorporation of standard commercial protocols and the Request Oriented Scheduling Engine (ROSE) which provides special features for conflict-free spacecraft scheduling such as goal-directed scheduling and repetitive activities with variable start times and durations. The development of a compact transponder, using new technology, suitable for use by new, small satellites was continued. This dual award procurement will provide engineering models and a small number of flight units from both Cincinnati Electronics and Motorola. These small satellite transponders expand Space Network/TDRS use to a new class of missions. A contract was initiated to design and develop a Ka-Band Phased Array Antenna. This system will enable Low Earth Orbiting (LEO) spacecraft to establish high data rate communications in the Ka frequency band, either to ground stations or via TDRSS-H, I, J.

The Space Network Customer Services program will provide for continued operations, maintenance, and modification of the NCC. The scheduling system modification will be completed and become operational. The communication and control segment modification effort will be initiated. This segment modification will complete the distributed architecture modifications and lower the life cycle cost of the Network Control Center.

The Service Planning Segment Replacement project will become operational in FY 1999 in the Space Network Control Center (NCC). This will start the implementation of the Network Control Center Data System into a workstation, Unix-based environment, resulting in an estimated 40 percent reduction in life cycle costs. Development of a fourth generation TDRS spacecraft communications system for use by small satellites will near completion while development efforts for the Ka-Band Phased Array Antenna will continue.

The requested funding also provides for continuation of mission planning, customer requirements definition and documentation, mission and network operational analyses, customer communications systems analyses, test coordination and conduct, and other customer support services. An interoperability demonstration with the TRMM spacecraft was conducted in FY 1998. Compatibility testing is planned for Landsat-7, EOS AM-1, International Space Station, WIRE, and upcoming National Oceanic and Atmospheric Administration (NOAA) missions in FY 1999. Simulations, engineering tests, and data flows will be conducted to verify communications designs and train mission control operators.

The Space Network Customer Services program will provide for continued operations, maintenance, and modification of the NCC. The Communications and Control Segment Replacement project will begin in the Space Network Control Center (NCC) in FY 1999 and will allow the completion of the implementation of the Network Control Center Data System into a workstation, Unix-based environment, resulting in an estimated 50 percent reduction in the amount of application code and a reduction in life-cycle cost. The fourth generation TDRS transponder will be available in FY 1999 and development efforts on the Ka-Band Phased Array Antenna will near completion.

In FY 2000, the Communications and Control Segment Replacement project in the Space Network Control Center (NCC) will become operational. The Ka-Band Phased Array Antenna will be completed. Also in this timeframe, the CSOC contractor, Lockheed Martin Space Operations Company, will be implementing architectural changes to reduce operations costs. One current area of consideration is consolidation of the NCC functions for the Space Network with scheduling functions for the Deep Space Network and Ground Network at a central location. These plans will be reviewed by the government as they are formulated.